Circular No. 786

March 1948 • Washington, D. C.

UNITED STATES DEPARTMENT OF AGRICULTURE

Improvement of Pastures for Dairy Cattle in Middle Tennessee

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INTRODUCTION

It is estimated that pastures contribute more than one-third of all the feed consumed by livestock in the United States and that more than one-third of the feed furnished by pastures is utilized by dairy cattle. Although pastures are an important source of feed for dairy cattle, pasture crops are usually the most neglected of all the crops grown on the farm.

Many experiments and demonstrations have shown that the yield and carrying capacity of pastures can be increased markedly by various methods, such as plowing or renovating, liming, fertilizing, and re-seeding to adapted mixtures of grasses and legumes. The nature of such an improvement program, however, will vary with the locality and must be adapted to the local conditions.

In an effort to provide useful information for dairy farmers in middle Tennessee and the adjacent areas to the north and south, the

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Bureau of Dairy Industry established 12 experimental grazing plots at the Lewisburg, Tenn., dairy field experiment station in the summer of 1942. This circular describes the methods of establishing the various plots and the annual treatment used, and gives the results obtained with grazing animals for the 4-year period 1943–46.

EXPERIMENTAL METHODS AND PROCEDURES

Land Used for the Experiment

The 29 acres of land selected for this comparison of different pasture improvement methods had been cleared of timber at least 75 years prior to the start of the experiment. The history of the use of the land during this 75-year period is not definitely known, except for the more recent years. It is probable, however, that it was in cultivated crops during the first 40 or 50 years after it was cleared.

Some of the land had been in permanent bluegrass pasture for about 30 years prior to its use in this experiment, and it was typical of many bluegrass pastures in middle Tennessee. So far as is known, the rest of the land had never been in permanent pasture but had been in cultivated crops for many years. Winter grain crops and Korean lespedeza had been grown and harvested for grain or hay during the 10 years immediately before the experiment began.

All the land had received a light application of manure 8 or 10 years before the start of the experiment, but obviously the land was very low in organic matter and available nitrogen when the experiment began. Soils of this area are generally high in phosphorus and potassium but low in lime.

Establishment of the Various Plots

Plots 1 to 4, inclusive, consisting of 2.3 acres each, were established on land that had been in permanent bluegrass pasture—the seedings being made without plowing or otherwise disturbing the sod.

Plots 5 to 8, inclusive, consisting of 2.6 acres each, were also established on land that had been in permanent bluegrass pasture, but the land was plowed and a good seedbed was prepared before the seed mixture was sown.

Plots 9 to 12, inclusive, consisting of 2.3 acres each, were established on land that had been in cultivated crops. The land was plowed and worked down to a good seedbed before it was seeded.

All plots, except plots 3 and 4, received an application of crushed limestone at the rate of 2 tons per acre before seedings were made.

Table 1 shows the seed mixtures used on each plot, also the cost of the various operations in the initial preparation and establishment of the plots.

Method of Measuring Pasture Yields and Costs

Yields of pasturage were calculated from records obtained by grazing the various experimental plots with producing Jersey cows, usually from April through October. An effort was made to keep the growth of grass on all plots grazed to the same extent, by increasing or decreasing the number of cows in accordance with the amount of grass available for grazing.

The cows received no other roughage than that furnished by the grazing plots, but they were fed a home-mixed grain ration. Records were kept of the amount of grain consumed, the amount of milk and butterfat produced, and the gain or loss in body weight. From such records, and from figures based on Morrison's feeding standard showing the nutrients required by cows under favorable conditions, it is possible to calculate the amount of total digestible nutrients furnished by an acre of pasture.

Records were also kept of the labor and farm machinery used in preparing the land, and in seeding, liming, manuring, mowing, and applying fertilizers, etc., and costs were computed for each of the various operations. The actual cost of man labor was used in these calculations, and reasonable allowances were made for the use of work mules and farm machines. The value of the milk produced was based on current prices at the local condensery and cheese factory, less hauling charges.

RESULTS OF THE VARIOUS TREATMENTS

Seedings on Undisturbed Bluegrass Sod

The bluegrass pasture on which plots 1, 2, 3, and 4 were established had been clipped with a mower one or more times each summer for at least 12 years prior to the start of this experiment. The plant growth and condition of all four plots appeared to be about the same. In addition to the bluegrass, there was a limited growth of white clover, some hop clover, and considerable broomsedge.

Plots 1 and 2 were limed at the start of the experiment, and thereafter they received annual applications of 3 to 5½ tons of manure per acre and were clipped with a mower once or twice each summer. Both plots were first seeded October 19, 1942, with 2 pounds of Louisiana white clover and 1 pound of hop clover per acre. On March 30, 1943, plot 1 received a second seeding which consisted of 5 pounds of Korean lespedeza and 5 pounds of common lespedeza per acre, but no further seedings were made on this plot. Plot 2 received an annual seeding of 15 pounds of crimson clover in October each year, except in 1945 when the rate was 10.6 pounds. Plot 3 received no treatment except clipping with a mower. Plot 4 received no treatment, since it was used as a check plot.

TABLE 1.—*Seed mixtures used and the initial cost of establishing the experimental grazing plots*

Plot No.	Seed mixture used	Initial cost of establishing the plots				Later annual treatment
		Cost of seed per acre [1]	Labor and equipment for land preparation and seeding	Applying 2 tons crushed limestone [2]	Total initial cost	
Seedings on Undisturbed Bluegrass Sod						
1	5 pounds Korean lespedeza; 5 pounds common lespedeza; 2 pounds Louisiana white clover; 1 pound hop clover.	$3.27	$1.00	$5.22	$9.49	Mowed; manured.
2	2 pounds Louisiana white clover; 1 pound hop clover	2.10	.50	5.22	7.82	Mowed; manured; crimson clover seeded on undisturbed sod.
3	Not seeded					Mowed.
4	do					None.
Seedings on Prepared Bluegrass Sod						
5	10 pounds orchard grass; 8 pounds bluegrass; 2 pounds Louisiana white clover; 1 pound hop clover.	$5.88	$6.00	$5.22	$17.10	Mowed; nitrate fertilizer.[3]
6	do	5.88	6.00	5.22.	17.10	Mowed.
7	do	5.88	6.00	5.22	17.10	Mowed; nitrate fertilizer; [3] phosphate fertilizer.
8	do	5.88	6.00	5.22	17.10	Mowed; manured.

9	10 pounds orchard grass; 8 pounds bluegrass; 2 pounds Louisiana white clover; 1 pound hop clover.	$5. 88	$6. 00	$5. 22	$17. 10	Mowed; manured; crimson clover seeded on established sod.
10	15 pounds orchard grass; 2 pounds Louisiana white clover	5. 35	6. 00	5. 22	16. 57	Mowed; manured.
11	15 pounds orchard grass; 2 pounds Ladino clover	5. 25	6. 00	5. 22	16. 47	Do.
12	2 pounds Louisiana white clover; 2 pounds Ladino clover; pieces of Bermuda grass sod. [4]	11. 80	6. 00	5. 22	22. 02	Do.

[1] Seed cost (cents per pound): Korean lespedeza 8¼; common lespedeza 15; Louisiana white clover 80; Ladino clover 75; bluegrass 16; orchard grass 25; hop clover 50.

[2] Crushed limestone cost $1.95 per ton delivered to the field; spreading cost 66 cents per ton.

[3] No nitrate fertilizer was applied during 1943.

[4] Setting pieces of Bermuda sod 7 to 8 feet apart cost $8.70 per acre for labor.

Table 2 shows the amount of total digestible nutrients obtained by the grazing cows, on an acre basis, for each of the 4 years and the average for each plot. The yields varied from year to year, but the average yields over the 4-year period are significant. For comparison, table 2 also shows the amount of alfalfa hay of good quality that would be required to supply the same amount of total digestible nutrients as was obtained from an acre of grazing.

TABLE 2.—*Annual and average yields of the grazing plots, and the amount of alfalfa hay required to furnish an equivalent amount of total digestible nutrients*

Plot No.	Yield of total digestible nutrients per acre in—					Alfalfa hay with an equivalent amount of total digestible nutrients
	1943	1944	1945	1946	4-year average	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Seedings on Undisturbed Bluegrass Sod						
1	983	1, 512	1, 518	1, 901	1, 478	2, 956
2	1, 254	1, 512	1, 466	1, 548	1, 445	2, 890
3	1, 012	1, 204	1, 306	1, 632	1, 288	2, 576
4	864	1, 228	1, 023	1, 082	1, 049	2, 098
Seedings on Prepared Bluegrass Sod						
5	--------	1, 705	1, 729	1, 538	[1] 1, 657	3, 314
6	1, 351	1, 502	1, 491	1, 181	1, 381	2, 762
7	1, 526	1, 734	1, 601	1, 441	[1] 1, 593	3, 150
8	1, 507	1, 750	2, 017	1, 857	1, 783	3, 566
Seedings on Land That Had Been in Field Crops						
9	2, 464	2, 270	2, 560	2, 339	2, 408	4, 816
10	2, 050	2, 194	3, 027	2, 779	2, 512	5, 024
11	3, 139	2, 652	3, 709	3, 169	3, 160	6, 320
12	2, 461	--------	--------	--------	--------	4, 922

[1] Yield for 1943 is not included in average because nitrate fertilizer was not available.

Plot 1 produced 41 percent more total digestible nutrients per acre than the check plot (plot 4), plot 2 produced 38 percent more, and plot 3 produced 23 percent more. There is some question as to how much of the increase in yield on plots 1 and 2 was the result of liming and manuring and how much was the result of the seedings. Observations indicated that liming and manuring were the chief factors. Both plots showed a noticeable increase in the amount of white clover and a decrease in broomsedge, but no noticeable change in the amount of

hop clover. The growth of bluegrass was improved and it had a darker green color than that in plots 3 and 4.

On plot 1, the seeding of Korean and common lespedeza produced a few scattering plants each year, but not enough to be a significant factor in the amount of grazing furnished. Apparently the bluegrass was too aggressive and gave the lespedeza little chance to gain a foothold.

On plot 2, the annual seedings of crimson clover produced a thin stand, which made poor growth in 1943, only a trace in 1944 and 1945, and none in 1946. Crimson clover did not add appreciably to the amount of grazing in the last 3 years, but in 1943 the growth was sufficient to be a factor. Calculations indicate that 31.6 percent of the total digestible nutrients furnished by plot 2 in 1943 were obtained during April and May, whereas only 23 percent of the total digestible nutrients furnished by plot 1 were obtained in April and May.

On plot 3, there was only a trace of white clover and no noticeable change in the amount over the 4-year period. The amount of broomsedge tended to increase, probably due to seeds spreading from the adjoining plot 4.

On plot 4, the amount of broomsedge increased decidedly. In addition, many redcedar trees appeared and reached a height of 4 to 6 feet during the 4-year period. Other trees and shrubs also appeared, including buck bush and blackberry briers, as well as quite a sprinkling of ironweeds, wild daisies, and other weeds. (See fig. 1.)

Seedings on Prepared Bluegrass Sod

Plots 5 to 8, inclusive, which were established on land that had previously been in permanent bluegrass pasture, and plot 9, which was on land that had always been in cultivated crops, furnish an opportunity for comparing the effects of nitrate and phosphate fertilizers, stable manure, and crimson clover.

These plots were plowed in the summer of 1942, limed at the rate of 2 tons per acre, worked down to a good seedbed, and seeded August 29 with the following mixture per acre: Orchard grass 10 pounds; bluegrass 8 pounds; Louisiana white clover 2 pounds; and hop clover 1 pound. (See table 1.) Along with this mixture, plot 9 was also seeded to crimson clover at the rate of 5.2 pounds per acre. Later annual seedings of crimson clover were made on plot 9 during October, at the rate of 15 pounds per acre in 1943 and 1944, and 10.8 pounds in 1945.

Plot 5 received applications of nitrate fertilizer per acre as follows: 50 pounds of ammonium nitrate April 17, 1944; 115 pounds of sodium nitrate April 30, 1945; and 57 pounds of ammonium nitrate April 17, 1946. Nitrate fertilizer was not available in 1943.

Plot 6 received no fertilizers or manure.

Plot 7 received nitrate fertilizers at the same rates and on the same dates as plot 5. In addition, plot 7 received applications of 20-percent superphosphate per acre as follows: 154 pounds August 28, 1942; 77 pounds April 17, 1944; 75 pounds April 30, 1945; and 115 pounds April 17, 1946.

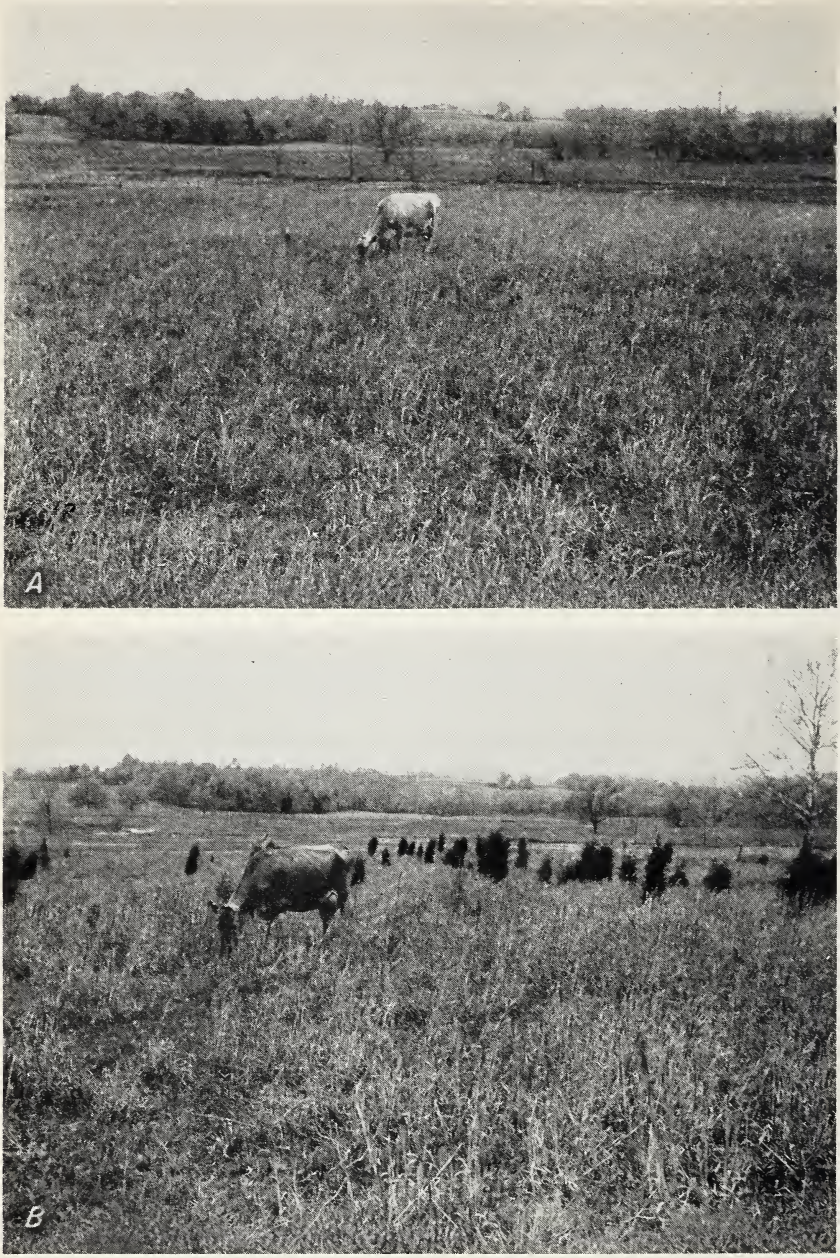

FIGURE 1.—Appearance of plot 3 (*A*) and plot 4 (*B*) on April 28, 1947. Plot 3 was mowed once or twice each year, whereas plot 4 received no treatment.

Plots 8 and 9 received annual applications of stable manure during winter months at rates varying from 3 to 5½ tons per acre.

The grasses and clovers seeded on these plots came up to an excellent stand, although the orchard grass was a little uneven because of uneven distribution of the seed in broadcasting. Excellent grazing was available on these plots by April 1943.

The average yields of total digestible nutrients per acre are shown in table 2. Compared with the average yield of 1,381 pounds on plot 6 (which received no fertilizers or manure), the application of nitrate fertilizer on plot 5 increased the yield of total digestible nutrients by 20 percent, nitrate plus phosphate on plot 7 increased the yield by 15 percent, manure on plot 8 increased the yield by 29 percent, and manure plus crimson clover on plot 9 increased the yield by 74 percent.

The growth of the grass on plots 5 and 7 increased considerably for several weeks after the nitrate fertilizers were applied. The color of the grass changed to a darker green within a day or two following the first rain after the nitrate was applied. The nitrate fertilizer, however, appeared to stimulate growth for only a few weeks after it was applied. There was nothing in the grazing results or in the appearance of the grass on plot 7 to indicate that the application of superphosphate was of any value. However, soils in this area are generally high in phosphorus. Plot 5, where no phosphate was applied, produced grazing at a slightly higher rate than plot 7 over the 4-year period.

The bluegrass in plots 5, 6, 7, and 8 did not become well enough established to furnish an appreciable proportion of the grazing during the first 2 years, and most of the available grazing came from the orchard grass and white clover. During the third and especially the fourth year, the bluegrass made rapid progress and tended to replace some of the orchard grass and white clover. The bluegrass made more progress in plot 8, which was manured, than in the other three plots.

On plot 9, the story was different. The 5.2 pounds of crimson clover included with the initial seeding of grasses and clovers resulted in crimson clover furnishing most of the grazing on plot 9 during 1943. Of the total grazing during 1943, 69.8 percent was obtained in April and May, and the crimson clover furnished practically all of the grazing that was available during these 2 months. The orchard grass survived competition with the crimson clover, but the white clover and bluegrass were almost completely smothered. A few small patches of white clover were visible by October 1943, and by the spring of 1946 the plot was well covered by white clover. Only a trace of bluegrass was found in the plot during 1943 and 1944, and it did not spread sufficiently to be of very much consequence in the grazing furnished during 1946.

Considerable volunteer crimson clover from the initial seeding in 1942 was already growing in plot 9 when the October 1943 seeding was made. Little crimson clover resulted from the 1943 seeding, however, and none resulted from the 1944 and 1945 seedings. The heavy growth of crimson clover during 1943 and the considerable volunteer growth during 1944 apparently had a beneficial effect on the orchard grass after 1943, which made a better growth on plot 9 than on other plots that were seeded to the same mixture without the crimson clover. The better growth of the orchard grass may have been due to an

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increased amount of available nitrogen and less competition from bluegrass than in the other plots, where bluegrass was also included in the seeding mixture. It will be recalled that plot 9 was on land that had been in field crops for many years, while plots 5 to 8 had been in permanent bluegrass pasture. This may be partly responsible for the increased yields for plot 9, as compared with plots 5 to 8.

Seedings on Land That Had Been in Field Crops

Plots 10, 11, and 12, which were established on land that had always been in cultivated crops, were plowed in the summer of 1942, worked down to a good seedbed, and seeded August 29 as follows: Plot 10 received 15 pounds of orchard grass and 2 pounds of Louisiana white clover per acre; plot 11 received 15 pounds of orchard grass and 2 pounds of Ladino clover per acre; plot 12 received 2 pounds of Louisiana white clover and 2 pounds of Ladino clover per acre, and in addition pieces of Bermuda grass sod were set 7 to 8 feet apart in this plot on April 2 and 3, 1943. (See table 1.)

Excellent grazing was available on all three plots by April 1, 1943. These plots, like the others, had received applications of crushed limestone at the rate of 2 tons per acre before they were seeded; and thereafter they received annual applications of stable manure during the winter months, at rates varying from 3 to 5½ tons per acre.

Plots 10 and 11 had excellent stands of Louisiana white clover and Ladino clover, respectively, in all 4 years. The Ladino clover was more aggressive than the white clover, however, and eventually extended from plot 11 into the adjoining plot 10 a distance of 10 or 12 feet. Both clovers have grown well with orchard grass, which, being a bunch grass, leaves room for clovers when seeded at the rate of 15 pounds per acre.

In plot 12, the Ladino clover apparently completely smothered the Louisiana white clover. Observations indicate that Ladino clover starts to bloom 2 or 3 weeks later than white clover, and there were no clover blooms of any kind in this plot until the Ladino in the adjoining plots started to bloom.

The Bermuda grass in plot 12 made very slow progress toward establishing a sod, because of the aggressiveness of the Ladino clover. Grazing data were obtained on plot 12 for 1943 only, although the plot was grazed all 4 years. By the end of the 1946 grazing season, it was apparent that the Bermuda grass probably would in time crowd out most of the Ladino clover.

The average yield of total digestible nutrients per acre on plots 10 and 11 is shown in table 2, along with the amount of alfalfa hay that would be required to furnish an equivalent amount of total digestible nutrients. The yields by these two plots exceeded those by any of the other plots, that of plot 11 being especially outstanding (fig. 2). The orchard grass and Ladino clover combination on plot 11 produced 201 percent more grazing than the untreated bluegrass on plot 4; 77 percent more than the combination of orchard grass, bluegrass, Louisiana white clover, and hop clover on plot 8; and 26 percent more than the combination of orchard grass and Louisiana white clover on plot 10.

From the yields given in table 2, it will be seen that plots 9, 10, 11, and 12, all of which were laid out on land that had been in field crops for many years, gave higher yields each year than the 8 other plots

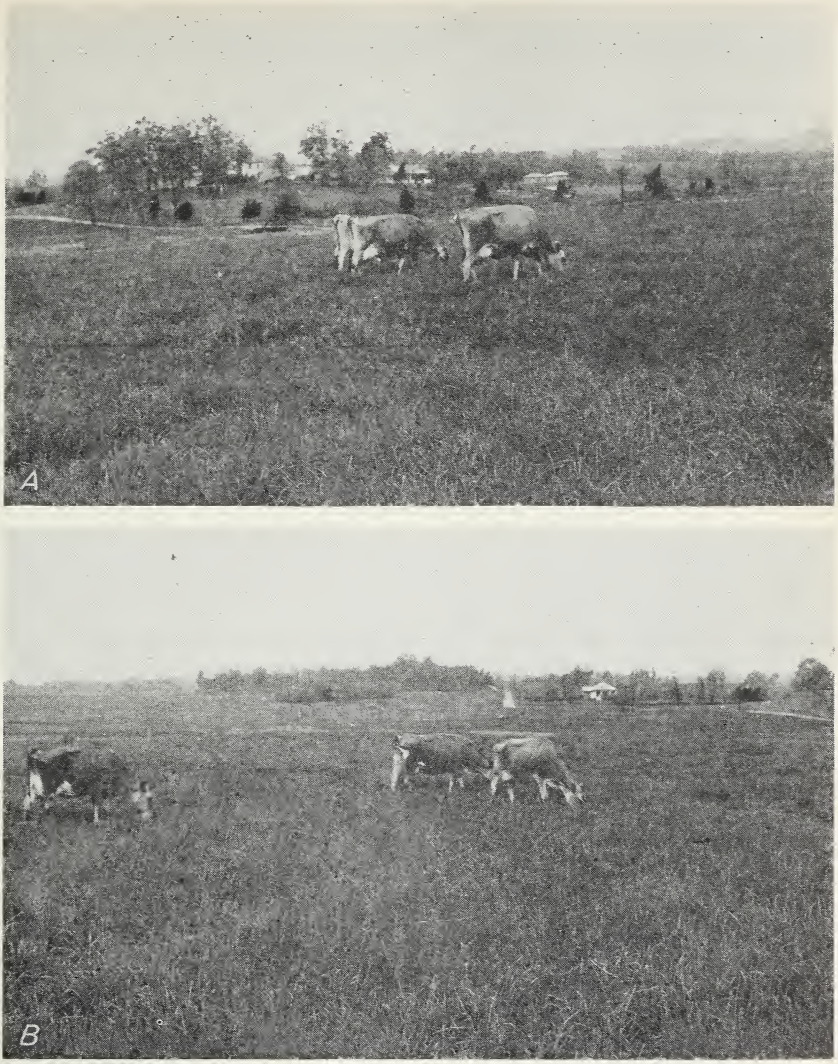

FIGURE 2.—Growth on plots 10*(A)* and 11*(B)*, April 28, 1947

that were laid out on land that had been in bluegrass sod. The previous system of management may have been partly responsible for the higher yields of these 4 plots, but the effect of the previous use of the land, of course, cannot be measured.

FINANCIAL RETURNS

As previously stated, records were kept of all operations and materials used. The records also included the amounts of milk produced and the grain consumed by the cows. From these records the net value of the milk, above the value of the grain consumed by the cows

and the cost of treating the pastures, was calculated. The results for each of the 4 years are shown in tables 3, 4, 5, and 6, and they are summarized in table 7.

The average net returns per acre per year, after deducting the prorated cost of seedbed preparation, seeding, and liming, are shown in the last column of table 7. It will be noted that the average returns for all plots follow the same trend as the average yields of total digestible nutrients, shown in table 2.

It is significant that plot 4, on which no annual expense of any sort was incurred, showed the lowest average return of any of the plots, or only $49.21 per acre per year. Plot 3, which received no annual treatment except mowing, returned $65.06 per acre per year, or an increase of $15.85 that can be credited to mowing. The average cost of mowing was $1.85 per acre per year, hence $1 spent for mowing resulted in an increased return of $8.57.

Plots 1 and 2, which were limed, manured, mowed, and received seedings of clovers on the sod, both showed higher net returns than plot 3. However, as previously mentioned, observations indicated that the better yields on plots 1 and 2 probably resulted from the lime and manure rather than from the seedings. If so, the net returns from these two plots would have been greater if the seedings had not been made.

Plot 6, which received no treatments after seeding except mowing, gave a net return of $60.37 per acre per year. Plot 5, which was mowed and which also received nitrate fertilizer, returned $75.21 per acre per year, or an increase of $14.84 for the nitrate fertilizer. The cost of applying nitrate fertilizer averaged $2.81 per acre per year. Therefore, each $1 spent for nitrate fertilizer resulted in an increased return of $5.26.

Plot 7, which received both nitrate and phosphate, returned an average of $77.37 per acre per year, or $17.00 more than plot 6 where no fertilizer was used. The average cost of the fertilizer was $4.05 per acre per year, and the increased return per $1 expended for fertilizer was $4.20. As previously noted in comparing the yields of total digestible nutrients obtained from plots 5 and 7, the inclusion of superphosphate on plot 7 was of no value. The return per dollar expended for fertilizer would have been greater, therefore, if only the nitrate fertilizer had been applied.

Plot 8, which was manured, gave a net return of $96.69 per acre per year, or $36.32 more than plot 6 which was not manured. The average cost for applying an average of 4.8 tons of manure per acre each year was $6.01. Therefore, each $1 expended in applying manure returned $6.04.

It appears from the foregoing comparisons that mowing, applying nitrate fertilizer, and manuring were all very profitable practices. Additional applications of nitrate fertilizer and heavier applications of manure would probably have increased grazing yields and net returns per acre.

The average net return from plot 9 was $129.06 per acre per year. The initial seeding of crimson clover on this plot, as previously noted, affected the pasture flora growing in this plot throughout the experimental period. The net return does not, therefore, show the effect of the later seedings of crimson clover on the sod.

TABLE 3.—*Milk produced per acre of grazing, and the net value above the cost of grain fed and the cost of pasture treatments in 1943*

Plot No.	Production per acre		Value of milk at 68 cents per pound of fat	Grain fed to cows		Cost of pasture treatments			Net value of milk above cost of grain and pasture treatments
	Milk	Butterfat		Amount	Cost [1]	Mowing [2]	Manure or fertilizer	Crimson clover seeding	
	Pounds	*Pounds*	*Dollars*	*Pounds*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1	2, 224	100. 0	68. 00	393	11. 08	1. 70	[3] 6. 65	0	48. 57
2	1, 873	92. 4	62. 83	302	8. 51	1. 70	[3] 6. 65	2. 00	43. 97
3	2, 064	106. 9	72. 69	324	9. 14	1. 70	0	0	61. 85
4	1, 602	77. 0	52. 36	344	9. 70	0	0	0	42. 66
5									
6	2, 576	118. 9	80. 85	369	10. 40	1. 70	0	0	68. 75
7	2, 723	138. 4	94. 11	356	10. 04	1. 70	[4] 1. 79	0	80. 58
8	2, 894	157. 7	107. 24	398	11. 22	1. 70	[3] 6. 65	0	87. 67
9	4, 186	223. 9	152. 25	636	17. 93	0	[3] 6. 65	[5] . 52	127. 15
10	3, 346	161. 1	109. 54	413	11. 65	1. 70	[3] 6. 65	0	89. 54
11	5, 890	270. 0	183. 60	815	22. 98	1. 70	[3] 6. 65	0	152. 27
12	4, 605	244. 5	166. 26	664	18. 72	1. 70	[3] 6. 65	0	139. 19

[1] Cost of grain mixture, $2.82 per cwt. Ingredients: 400 pounds ground barley; 200 pounds ground oats; 100 pounds soybean meal.
[2] All plots were mowed twice except plots 4 and 9 which were not mowed.
[3] Cost of labor and equipment used in applying approximately 5½ tons manure.
[4] Cost of applying, previous to seeding date, 154 pounds of 20-percent superphosphate, including labor and equipment.
[5] Cost of 5.2 pounds crimson clover seeded when initial seeding of grass was made.

TABLE 4.—*Milk produced per acre of grazing, and the net value above the cost of grain fed and the cost of pasture treatments in 1944*

Plot No.	Production per acre		Value of milk at 68 cents per pound of fat	Grain fed to cows		Cost of pasture treatments			Net value of milk above cost of grain and pasture treatment
	Milk	Butterfat		Amount	Cost [1]	Mowing	Manure or fertilizer	Crimson clover seeding [2]	
	Pounds	*Pounds*	*Dollars*	*Pounds*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1	2,235.5	106.6	72.49	393	10.57	[3] 1.74	[4] 4.80	0	55.37
2	2,835.3	136.6	92.89	456	12.27	[3] 1.74	[4] 4.10	2.15	72.63
3	2,083.9	96.1	62.29	375	10.09	[3] 1.74	0	0	50.46
4	1,534.9	75.6	51.41	244	6.56	0	0	0	44.85
5	3,100.8	135.7	92.28	535	14.39	[5] 2.61	[6] 2.06	0	73.22
6	2,388.4	112.3	76.36	416	11.19	[5] 2.61	0	0	62.56
7	3,131.5	147.5	100.30	537	14.44	[5] 2.61	[7] 3.23	0	80.02
8	3,471.1	168.2	114.38	580	15.60	[5] 2.61	[4] 3.74	0	92.43
9	4,160.0	188.5	128.18	695	18.69	[3] 1.74	[4] 4.27	2.15	101.33
10	4,983.6	221.0	150.28	803	21.60	[8] .87	[4] 3.87	0	123.94
11	5,995.7	244.3	166.12	964	25.93	[8] .87	[4] 4.71	0	134.61
12									

[1] Cost of grain mixture, $2.69 per cwt. Ingredients: 3,000 pounds ground barley; 1,000 pounds soybean meal; 800 pounds chopped hay.
[2] Crimson clover seeded Oct. 13, 1943, on sod at rate of 15 pounds per acre.
[3] Mowed twice.
[4] Cost of labor and equipment for applying 3 to 4 tons of stable manure.
[5] Mowed three times.
[6] Nitrate of soda, 50 pounds, applied Apr. 17, 1944.
[7] Nitrate of soda, 50 pounds; superphosphate, 77 pounds, applied Apr. 17, 1944.
[8] Mowed once.

TABLE 5.—*Milk produced per acre of grazing, and the net value above the cost of grain fed and the cost of pasture treatments in 1945*

Plot No.	Production per acre		Value of milk at 69 cents per pound of fat	Grain fed to cows		Cost of pasture treatments			Net value of milk above cost of grain and pasture treatment
	Milk	Butterfat		Amount	Cost [1]	Mowing	Manure or fertilizer	Crimson clover seeding [2]	
	Pounds	*Pounds*	*Dollars*	*Pounds*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1	2,268.6	118.4	81.70	373.7	10.43	[3] 1.74	[4] 6.04	0	63.49
2	2,679.9	138.4	95.50	469.6	13.10	[3] 1.74	[4] 6.04	2.15	72.47
3	1,741.1	90.7	62.58	213.3	5.95	[3] 1.74	0	0	54.89
4	1,580.1	79.3	54.72	274.3	7.65	0	0	0	47.07
5	2,831.6	141.2	97.43	492.3	13.73	[3] 1.74	[5] 3.39	0	78.57
6	2,098.9	114.8	79.21	306.0	8.54	[3] 1.74	0	0	68.93
7	2,823.3	139.8	96.46	436.1	12.17	[3] 1.74	[6] 4.56	0	77.99
8	3,298.8	178.4	123.09	552.3	15.41	[3] 1.74	[4] 6.04	0	99.90
9	5,184.9	254.5	175.60	805.9	22.48	[7] .87	[4] 6.04	2.15	144.06
10	6,096.6	298.9	206.24	1,034.3	28.86	[7] .87	[4] 6.04	0	170.47
11	7,461.8	360.7	248.88	1,232.8	34.39	([8])	[4] 6.04	0	208.45
12									

[1] Cost of grain mixture, $2.79 per cwt. Ingredients: 3,000 pounds ground barley at $2.71; 700 pounds soybean meal or cottonseed meal at $3; 800 pounds chopped hay at $1.50; grinding and mixing, $0.25.

[2] Crimson clover, 15 pounds, seeded Oct. 17, 1944.

[3] Mowed twice.

[4] Cost of labor and equipment for applying 5¼ tons of stable manure.

[5] Nitrate of soda, 115 pounds, applied Apr. 30, 1945.

[6] Nitrate of soda, 115 pounds, plus 75 pounds superphosphate, applied Apr. 30, 1945.

[7] Mowed once.

[8] Mowing considered unnecessary.

TABLE 6.—*Milk produced per acre of grazing, and the net value above the cost of grain fed and the cost of pasture treatment in 1946*

Plot No.	Production per acre		Value of milk at 86 cents per pound of fat	Grain fed to cows		Cost of pasture treatments			Net value of milk above cost of grain and pasture treatment
	Milk	Butterfat		Amount	Cost [1]	Mowing	Manure or fertilizer	Crimson clover seeding [2]	
	Pounds	*Pounds*	*Dollars*	*Pounds*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1	3, 230. 9	159. 2	136. 91	625. 6	19. 77	[3] 2. 22	[4] 7. 44	0	107. 48
2	2, 927. 5	159. 9	137. 51	568. 7	17. 97	[3] 2. 22	[4] 8. 03	2. 38	106. 91
3	2, 387. 5	129. 2	111. 71	520. 4	16. 44	[3] 2. 22	0	0	93. 05
4	1, 547. 2	85. 4	73. 44	291. 1	9. 20	0	0	0	64. 24
5	2, 649. 1	126. 2	108. 53	527. 9	16. 68	[3] 2. 22	[5] 2. 99	0	86. 64
6	1, 713. 9	84. 4	72. 58	380. 4	12. 02	[3] 2. 22	0	0	58. 34
7	2, 444. 8	124. 7	107. 24	427. 1	13. 50	[3] 2. 22	[6] 4. 35	0	87. 17
8	3, 852. 6	184. 9	159. 01	801. 3	25. 32	[3] 2. 22	[4] 7. 62	0	123. 85
9	4, 519. 6	229. 3	197. 20	799. 8	25. 27	[7] 1. 11	[4] 7. 64	2. 38	160. 80
10	5, 658. 9	261. 4	224. 80	993. 3	31. 39	[7] 1. 11	[4] 8. 55	0	183. 75
11	6, 539. 6	317. 6	273. 14	1, 212. 6	38. 32	[7] 1. 11	[4] 8. 00	0	225. 71
12									

[1] Cost of grain mixture, $3.16 per cwt. Ingredients: 3,000 pounds ground barley at $3; 700 pounds cottonseed meal at $4.13; 800 pounds chopped hay at $1.50; grinding and mixing, $0.25.

[2] Crimson clover, 10.6 pounds, seeded Oct. 25, 1945.

[3] Mowed twice.

[4] Cost of labor and equipment for applying approximately 5 tons of stable manure.

[5] Ammonium nitrate, 57 pounds, applied Apr. 17, 1946.

[6] Ammonium nitrate, 57 pounds, and 20-percent superphosphate, 115 pounds, applied Apr. 17, 1946.

[7] Mowed once.

TABLE 7.—*Average net return per acre resulting from the different pasture improvement practices*

Plot No.	Net value of milk above cost of grain and pasture treatments in—					Cost of establishing plot [1]		Average net return per acre, after deducting annual charge for establishing plot
	1943	1944	1945	1946	Average	Total	Annual prorated charge [2]	
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1	48. 57	55. 37	63. 49	107. 48	68. 72	9. 49	2. 37	66. 35
2	43. 93	72. 63	72. 47	106. 91	73. 98	7. 82	1. 95	72. 03
3	61. 85	50. 46	54. 89	93. 05	65. 06	0	0	65. 06
4	42. 66	44. 85	47. 07	62. 24	49. 21	0	0	49. 21
5		73. 22	78. 57	86. 64	79. 48	17. 10	4. 27	75. 21
6	68. 75	62. 56	68. 93	58. 34	64. 64	17. 10	4. 27	60. 37
7	80. 58	80. 02	77. 99	87. 17	81. 64	17. 10	4. 27	77. 37
8	87. 67	92. 43	99. 90	123. 85	100. 96	17. 10	4. 27	96. 69
9	127. 15	101. 33	144. 06	160. 80	133. 33	17. 10	4. 27	129. 06
10	89. 54	123. 94	170. 47	183. 75	141. 92	16. 57	4. 14	137. 78
11	152. 27	134. 61	208. 45	225. 71	180. 26	16. 47	4. 12	176. 14
12	139. 19							

[1] Includes cost of seedbed preparation, liming, and seeding.
[2] Seeding cost prorated over 4-year period.

Plots 8, 10, and 11 were all treated in the same way except for the seeding mixtures that were used. Therefore, these three plots afford a comparison of the results from three different seeding mixtures. The average net return per acre per year from plot 8 (orchard grass, bluegrass, Louisiana white clover, and hop clover) was $96.69; from plot 10 (orchard grass and Louisiana white clover), it was $137.78; and from plot 11 (orchard grass and Ladino clover), it was $176.14.

The returns from plots 10 and 11, where bluegrass was not included in the seeding mixture, were higher than from plot 8, where bluegrass was included. Also, the return from plot 11, where Ladino clover was seeded with orchard grass, was considerably higher than from plot 10, where Louisiana white clover was seeded with orchard grass.

All of the grasses and clovers used in this experiment, except Ladino clover, are well known in the middle section of Tennessee. Experience with Ladino clover is limited. In this experiment, Ladino clover was seeded during the latter part of August on a well prepared seedbed that had been limed previous to seeding. Also, random seedings have been made on the pasture sod in some of the permanent pastures on the experimental farm. These random seedings on sod have not resulted in a stand of Ladino clover, indicating that Ladino clover will not be of value when seeded directly on sod. As handled in this experiment, however, the Ladino clover produced very satisfactory growth throughout the grazing season from April through October when soil moisture was sufficient to produce growth of bluegrass, orchard grass, and other clovers.

EFFECT OF DISTRIBUTION OF RAINFALL ON SEASONAL GROWTH

The rainfall during each month, from March through October, is shown in table 8. The normal rainfall for each month is also shown. The amount of rainfall fluctuated greatly and varied widely from normal at some time during each of the 4 years. This fluctuation resulted in wide variation in the amount of grazing that was available at different times. This is indicated in figure 3, which shows the distribution of rainfall and the production of total digestible nutrients by months for plots 4, 8, and 11 for the grazing season of 1946. This graph (fig. 3) shows that the most grazing was not necessarily obtained dur-

TABLE 8.—*Monthly rainfall during the 4-year experimental period*

Year	Inches of rainfall in—								
	March	April	May	June	July	Aug.	Sept.	Oct.	Total
1943	5. 68	5. 24	2. 75	2. 91	5. 74	2. 01	7. 41	1. 14	32. 88
1944	9. 25	4. 60	4. 56	1. 83	2. 79	2. 85	8. 78	1. 15	35. 81
1945	3. 62	6. 14	6. 82	3. 49	3. 86	1. 75	2. 76	2. 62	31. 06
1946	5. 97	2. 47	5. 58	1. 70	4. 88	2. 02	4. 87	1. 60	29. 09
Normal	5. 78	4. 58	4. 25	4. 25	4. 24	4. 51	3. 01	3. 30	33. 92

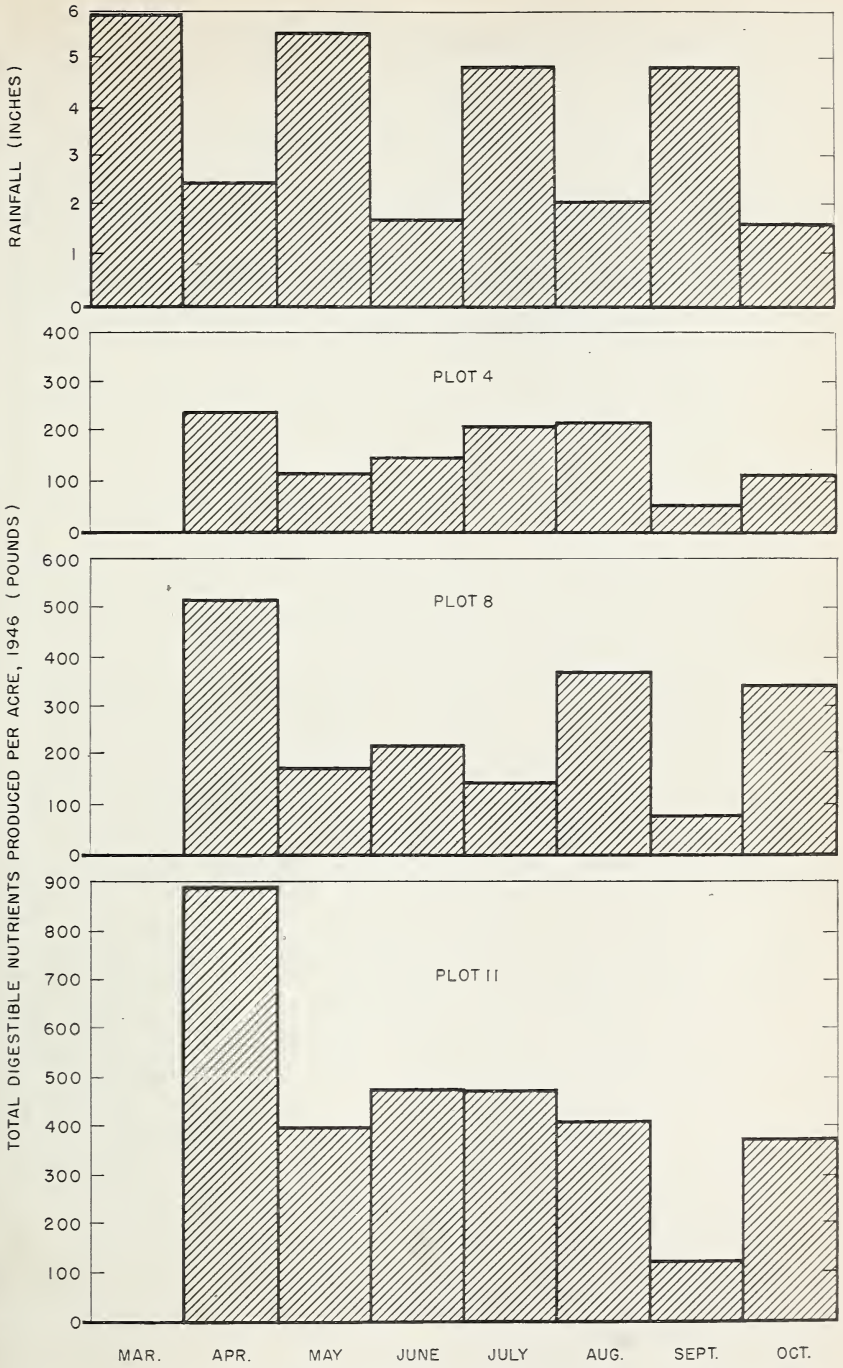

FIGURE 3.—Relation between monthly rainfall and yield of total digestible nutrients on plots 4, 8, and 11, in 1946

ing the months of greatest rainfall. The pastures required 2 or 3 weeks to recover when ample rainfall followed a dry period. Likewise, the amount of grazing was not seriously affected for 2 to 3 weeks when a dry period followed one of ample rainfall.

SUMMARY AND CONCLUSIONS

A study of the over-all results obtained by grazing the various experimental plots reveals some interesting and significant possibilities for pasture improvement.

Four plots were established on undisturbed bluegrass sod that had been in pasture for many years. The two plots (plots 1 and 2) that received an initial application of 2 tons of crushed limestone per acre and annual applications of manure produced 41 and 38 percent more total digestible nutrients per acre, respectively, than the untreated plot 4. Although both plots were also seeded to clovers and lespedeza, observations indicated that the increased yields were due largely to the lime and manure rather than to the seedings on the sod.

Plot 3, which received no treatment except mowing about twice a year, produced 23 percent more nutrients than the untreated plot 4, indicating that mowing alone is a worth-while practice.

Furthermore, the increased carrying capacity on plots 1, 2, and 3 was progressively greater each succeeding year, with one exception (plot 2, 1945). This is significant, in that it indicates the value of lime, manure, and mowing for progressive improvement in the carrying capacity of permanent bluegrass pastures.

Plot 4, the untreated check plot, was typical of many pastures used for dairy cattle in middle Tennessee. Using the returns from plot 4 as a basis for comparison, it can be seen from the average returns on plots 1 and 2 that a dairyman could increase his pasture returns by $19.98 per acre by spending $8.65 for seed, lime, mowing, and hauling manure. Mowing alone (plot 3) increased the average net returns by $15.85 per acre. Although the seeding of clovers and lespedeza on unprepared sod of this kind was of questionable value, it paid decidedly to apply lime and manure, and to mow the pasture once or twice each season.

Four of the plots were seeded on prepared bluegrass sod to a mixture of orchard grass, bluegrass, Louisiana white clover, and hop clover. Another plot was seeded to the same mixture on prepared land that had been in field crops for several years, and crimson clover was later seeded on the pasture sod on this plot. Manure and nitrate and phosphate fertilizers were applied to some of the plots. The application of nitrate fertilizer increased the yield of total digestible nutrients by 20 percent, or from 2,762 pounds per acre to 3,314 pounds per acre. Nitrate plus phosphate increased the yield by 15 percent, and manure increased the yield by 29 percent. The application of manure plus a seeding of crimson clover in the fall increased the yield by 74 percent. A portion of the 74-percent increase, however, was undoubtedly due to the fact that the plot was located on land that had been in field crops and not in bluegrass sod. That crimson clover added materially to the grazing, however, is shown by the fact that 69.8 percent of the grazing was furnished during April and May—the 2 months when crimson clover was abundant.

On land that had been in field crops for several years, Ladino clover proved more aggressive in growth than Louisiana white clover. Both of these clovers were seeded with orchard grass and the land was manured. Both clovers, however, grew well with orchard grass. The plot seeded to Ladino clover and orchard grass furnished an average of 3,160 pounds of total digestible nutrients per acre and gave a net return of $176.14, which was a 26-percent greater yield and a 27-percent greater return than from the plot seeded to orchard grass and Louisiana white clover. The grazing produced by the orchard grass and Ladino clover combination was outstanding. It produced 201 percent more grazing than the untreated plot of bluegrass sod, and the returns per acre were three and one-half times greater.

U. S. GOVERNMENT PRINTING OFFICE: 1948

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